COMPARATIVE NOTES ON HYMENOPTERAN PARASITOIDS IN BUMBLE BEE AND HONEY BEE COLONIES (HYMENOPTERA: APIDAE) REARED ADJACENTLY[1]

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ABSTRACT: Colonies of both honey bees and bumble bees are often infested by parasitoids as well as by wax moths from several genera of the family Pyralidae. The nest associates in turn are parasitized by several groups of hymenopteran parasitoids. Colonies of bumble bees raised in close proximity to honey bee colonies provided an unanticipated opportunity to observe parasitoids that might be able to switch from honey bees or their nest associates, to bumble bees or their nest associates, and *vice versa*. This natural experiment indicated that none of the lepidopteran nest associates were shared between both honey bee and bumble bee colonies. However, most of the hymenopteran parasitoids of *Apis* nest associates were found to parasitize bumble bee nest associates. Diagnostic illustrations of some of the parasitoids from the apid colonies are provided to facilitate future observations on these species.

Bumble bees (*Bombus* and *Psithyrus* spp.) and honey bees (*Apis* spp.) share taxonomic assignment to the same family (Apidae) and the habit of being social. Nevertheless, they exhibit vastly different forms of nest construction, colony cycles (Michener, 1974) and division of labor (Cameron 1989). A number of North American records have been published on the nest associates, parasites, and parasitoids of each of these two groups (e.g. Frison 1926; Holm 1960; Milum 1939; Plath 1922, 1924), although little has been reported on the ability or tendency of their respective nest associates and natural enemies to share hosts. Honey bees are not native to North America and neither are most of their nest associates, largely due to the transport of these bees by humans.

During the summer of 1987, we had the opportunity to make direct observations on nest associates and natural enemies of both bumble bees and honey bees reared in close proximity to each other, and to record which of these bee-associated insects were found in nests of both groups. Below we describe the results of this survey, briefly suggest some possible explanations for the patterns observed, and provide some description of some of the parasitoids as an aid for future identification in field studies.

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STUDY CONDITIONS

Free-foraging colonies of *Bombus bimaculatus* Cresson, *B. fervidus* (Fabricius), *B. impatiens* Cresson, and *B. vagans* Smith were reared using modifications of standard procedures (Plowright & Jay 1966) at the Ohio State University Honey Bee Laboratory during the summer of 1987 in outdoor observation shelters. Forty colonies were established in wooden and plexiglas nest boxes from single queens collected in the spring within a 125-km radius of Columbus, Ohio. The colonies were situated within 10-50 meters of honey bee colonies under observation at the OSU bee lab. Several old, greater wax-moth *(Galleria melonella* L.) infested honey bee frames were present at the laboratory (approx. 15m away) as a potential source of both wax moth and honey bee parasitoids. Lepidopteran nest associates and hymenopteran parasitoids were allowed to develop naturally in the bumble bee and honey bee colonies to observe which nest associates and parasitoids entered and completed development in both honey bee and bumble bee colonies. Colonies were visually inspected daily for the entire summer; the chance that developing parasitoids went unobserved was small.

RESULTS

Parasitoids of Bumble Bees and Honey Bees

The results of the rearing survey are summarized in Table 1. An infestation of the gregarious pupal parasitoid, *Melittobia chalybii* Ashmead (Eulophidae), in old bumble bee nests was not accompanied by any appear-

Table 1. Lepidopteran nest associates and bee and moth parasitoids reared from honey bee and bumble bee colonies established near one another in Columbus, Ohio. Numbers in parentheses after *Melittobia chalybli* indicate number of parasitized hosts.

	Source Bee Colonies				
	A. mellifera	*B. bimaculatus*	*B. fervidus*	*B. impatiens*	*B. vagans*
Lepidoptera					
Galleria melonella	200+	0	0	0	0
Vitula edmandsae	0	12	10	5	2
Plodia interpunctella	3	0	0	0	0
Nemapogon sp.	0	0	1	0	0
Hymenoptera					
Apanteles galleriae	90	25	0	0	0
Apanteles nephoptericis	0	4	9	0	2
Bracon hebetor	36	22	3	2	0
Venturia canescens	10	1(?)	0	0	0
campoplegine sp.	0	0	1	0	0
Melittobia chalybii	0	2000+ (9)	0	400 (2)	0

ance of this species in honey bee colonies or old frames. The larvae and pupae of *M. chalybii* infesting bumble bee pupal cells are shown in Figures 1 and 2. *M. chalybii* has been reported previously from several species of nest-building Hymenoptera, including bumble bees and leafcutter bees (Edwards & Pengelly 1966; Hobbs & Krunic 1971; MacFarlane & Donovan 1989). Although the species of *Melittobia* often have been taxonomically confused and host records have been notoriously suspect, a recent revision of the genus (Dahm, 1984a, b) has clarified many of the host records.

The biology of *M. chalybii* and related species has been well studied (see, e.g., Howard 1891; Buckell 1928; Schmieder 1933; Schmieder & Whiting 1947; Hobbs & Krunic 1971; Dahms 1984b). It is a gregarious eulophid ectoparasitoid, principally attacking prepupal and pupal Hymenoptera (although records from other laboratory studies suggest a broader host range is possible (Gordh 1979). Hobbs & Krunic (1971) reported that the adult females were easily able to enter apparently closely-fitting containers to parasitize their hosts, and that an average of 175 adults could be reared from a single prepupa leafcutter bee (*Megachile rotundat*a [F.]). The ability of the females to enter new nest boxes with ease was observed in our study also. However, the number of parasitoids that emerged from a single bumble bee prepupa or pupa varied greatly (Table 1), depending on the species of the host bee attacked, but nonetheless averaged well above 175 individuals, no doubt due to the large size of the bumble bees. The bumble bee prepupae or pupae were virtually consumed by the *M. chalybii* larvae, leaving only a shrivelled skin.

Melittobia did not directly parasitize honey bees during our study.

Nest Associates and their Parasitoids

Greater wax moths (*Galleria mellonella* L.) were present in large numbers in old honey bee frames but were not found in any of the bumble bee colonies. A second species of moth, the common stored-products pest *Plodia interpunctella* (Hübner) (Pyralidae), was also present in low numbers only in the old *Apis* frames. Two other species of moth larvae, *Vitula edmandsae* (Packard) (Pyralidae) and *Nemapogon* sp. (Tineidae), were found only in the bumble bee nests, late in the season. *V. edmandsae* commonly has been reported from bumble bee nests (Heinrich, 1956), and was relatively abundant in our study. *G. mellonella, P. interpunctell*a and *V edmandsa*e all belong to the Pyralidae, but are not especially closely related within that family (Solis & Mitter 1992).

Two species of braconid parasitoids, *Apanteles galleriae* Wilkinson and *Bracon hebetor*. Say, normally reported from honey bee colonies, were found to parasitize both *Galleria* and *Vitula* in honey bee and bumble bee colonies, respectively. *A. galleriae* was originally described from the Old World (Wilkinson, 1932) but was transported to North America along with *Apis*

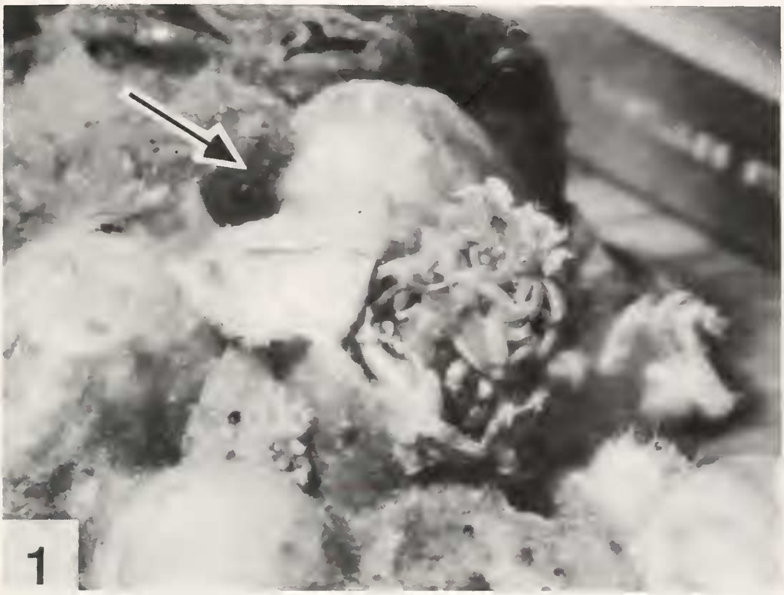

Figure 1. *B. bimaculatus* pupal cell opened to show gregarious *Melittobia* larvae on *Bombus* pupa. Adult *Melittobia* just visible at left (arrow).

Figure 2. *B. bimaculatus* cell opened to show *Melittobia* pupae.

colonies many years ago. There are no previous reports of *A. galleriae* from bumble bee colonies. *A. galleriae* is a solitary endoparasitoid of early-instar *Galleria* larvae; the larger later instar moth larvae are not commonly attacked. When attacking *V. edmandsae*, *A. galleriae* emerges from later-instar larvae.

B. hebetor, on the other hand, is an ectoparasitoid (Fig. 3) capable of parasitizing larvae of many ages. The larger hosts ultimately provide for a larger number of the gregarious parasitoid progeny. *B. hebetor* is one of the most fully-studied parasitoid wasps, and has been the subject of many developmental, physiological, behavioral and genetic investigations (e.g. Hase 1924; Morrill 1942; Martin 1947; Grosch 1948a, b; Beard 1952; Drenth 1974; Steiner 1986).

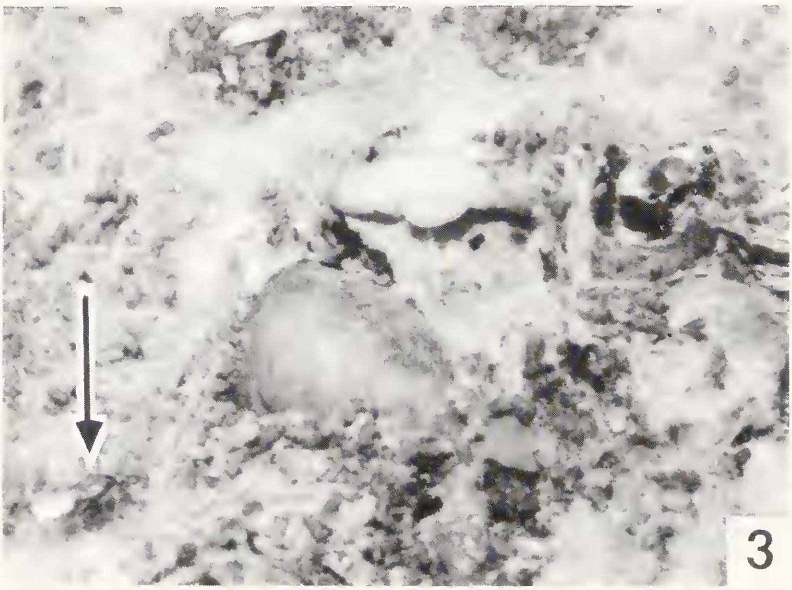

Figure 3. *Bracon hebetor* larva attached to host *Vitula* larva in infested nest of *Bombus bimaculatus*. Adult *Bracon* just visible at lower left (arrow).

A third braconid parasitoid, *Apanteles nephoptericis* Ashmead, attacked only *Vitula* larvae in the old bumble bee nests. *A. nephoptericis* has been reported previously to attack *Vitula* and other pest Lepidoptera on stored products (Marsh 1979).

An ichneumonid parasitoid, *Venturia canescens* (Gravenhorst), was reared from nest associate Lepidoptera in infested honey bee colonies, but was not reared from bumble bee colonies, although one adult female was discovered flying into an abandoned bumble bee nest and may have been searching for hosts. Carlson (1979) reports that specimens from undetermined hosts in bumble bee nests are present in the U.S. National Museum. The biology of *V. canescens* is well-studied (Frilli 1965; Carlson in Krombein *et al.* 1979), and it is one of the few Ichneumonidae for which careful studies have been made of host preferences and survivorship in different hosts (Salt 1964, 1975, 1976). As wax consumers in bumble bee colonies. *V. edmandsae* larvae are potentially within the "natural" host range of *V. canescens.*

In Figure 4, we have provided some identification aids for these ichneumonoid parasitoids from bumble bee and honey bee colonies.

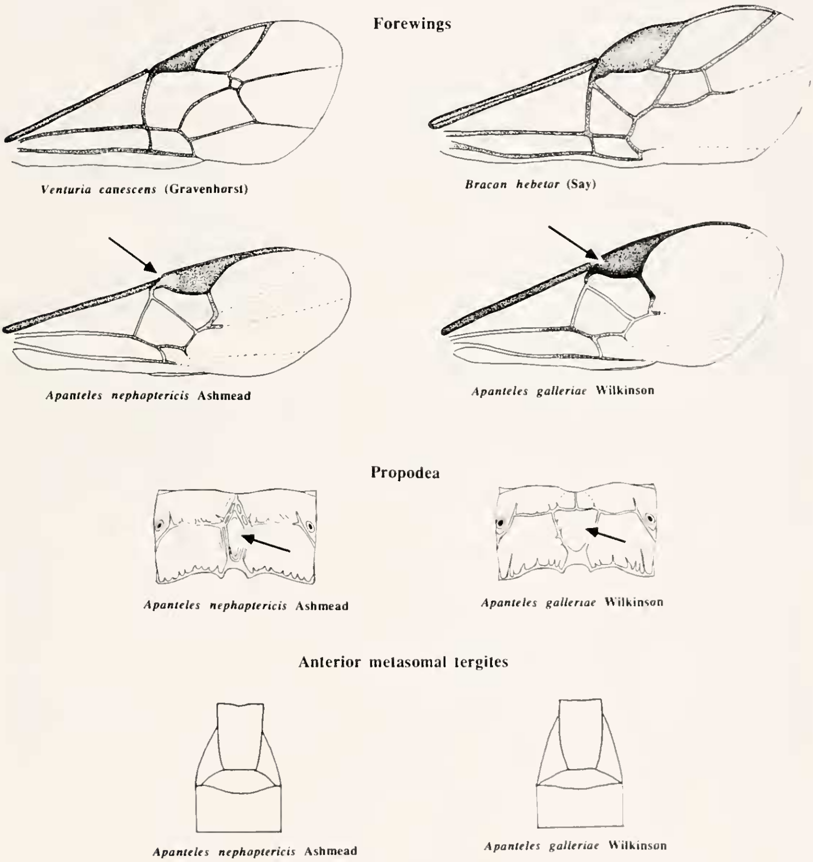

Figure 4. Morphological characteristics of the principal ichneumonoid parasitoids found in North American apid colonies. Arrows indicate differences in pterostigmal pigmentation or differences in the shape of the medial areola on the propodeum (posterior face of functional "thorax"). For additional taxonomic information concerning these species, see (Wilkinson, 1932; Nixon, 1976; Papp, 1980; Quicke, 1987; Wahl, 1987).

CONCLUSIONS

These observations indicate that none of the lepidopteran nest associates switched between honey bee and bumble bee colonies. The greater wax moth *G. mellonella* was specific to honey bee nests, while *V. edmandsae* was found only in bumble bees nests. On the other hand, some of the hymenopteran parasitoids attacked nest associates within both honey bee and bumble bee colonies. In particular, *A. galleriae* was a parasitoid on *G. mellonella* and *V. edmandsae*, and *B. hebetor* was reared from the nests of several bumble bees as well as from honey bees. In contrast, the parasitoid *M. chalybii* attacked only the prepupal or pupal stages of *B. bimaculatus* and *B. impatiens*. *V. canescens* was reared only from honey bee colonies, although an adult was found searching inside a colony of *B. bimaculatus*.

Differences in the colony hygiene of the bees may be largely responsible for the absence of some of the nest associates and parasitoids, such as *Melittobia*, in honey bee colonies. Honey bees actively remove infected brood from the nest, while bumble bees do not. Furthermore, bumble bees may be especially susceptible to this species (and to the moth *V. edmandsae*) as a result of the gradual abandonment of their nests at the end of each annual colony cycle. Because the nest is eventually abandoned and usually not reused (at least in temperate regions), it is not imperative to exclude parasitoids and wax moths from the nest late in the season.

The absence of *A. nephoptericis* from honey bee colonies may be due in part to a lack of synchrony between the availability of appropriately aged larvae of *Galleria* and the emergence of *A. nephoptericis* from *Vitula* larvae, and in part to colony hygiene in honey bee colonies. It is also possible that *A. nephoptericis* is unable to survive in *Galleria* larvae due to the internal defense reactions of the host. Laboratory studies to examine this possibility would be useful.

Our results clearly indicate that given the opportunity, some or most of the parasitoids of *Apis* nest associates are able to parasitize bumble bee nest associates. This has rarely been noted in nature, probably because (1) bumble bee nests are usually subterranean, while the introduced *Apis* nests are not; (2) bumble bee nests are abandoned at the end of each year, and are rarely studied after the nest is abandoned, and (3) bumble bee wax moths usually enter at the end of the season, often after the bumble bees have left. Further studies are needed to determine whether the *Apis* colony-associate parasites found in our domesticated bumble bee colonies occur in wild bumble bee nests.

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